TABLE 14

HIGH RISE STRUCTURAL STEEL BUILDINGS

Buildings in course of construction not listed

Bldg. No.	District Location	Building Information			Earthquake Damage			Epicentral Distance (miles)
		Constr. Date	Stories Above/Below Grade	Area*	Exterior and Ornamentation	Interior and Contents	Building Equipment	
1	Wilshire	57-59	6/3	350,000	Marble facing crkd.	Filing cabinets over, ML&P part. crkd.	AC & boilers moved	22.5
2	Beverly Hills	1955	8/1	92,000	Windows 5th & 7th	Part., ceiling tiles damg.	None	22.0
3	Beverly Hills	59-60	8/1	85,000	Windows 3rd	ML&P stairwell crkd. 4th to 6th	Slight damg. elev. wts.	22.0
4	Van Nuys	63-64	8/0	97,000	Lobby walls crkd. 4th thru 7th	ML&P part. crkd. Restr. damg. 2nd	None	14.0
5	Sherman Oaks	64-65	8/1	45,000	Windows 1st, 4th, 8th	Books, pictures fell	Elev. wts. loose	17.0
6	Sunset Strip	60-61	9/3	100,000	Front window	File cabinets, books, light fixtures fell	None	20.0
7	Hollywood	63-64	10/0	110,000	Conc. ext. walls crkd.	Intr. walls crkd., books fell, furn. damg.	None	20.0
8	Beverly Hills	63-64	10/1	100,000	None	All flrs. ML&P crkd., ceiling tile fell	Slight to elev.	22.0
9	Downtown L.A.	62-63	11/2	280,000	Windows broke & shifted	L&P walls crkd. all flrs.	None	24.0
10	Hollywood	58-59	12/1	102,000	Windows 2, 5, 6, 8, 9	So. stairwells damg.	None	20.0
11	Miracle Mile	55-56	12/1	110,000	Ext. conc. wall crkd.	Books, lamps, file cabinet fell	AC yoke broke	22.5
12	Sunset Strip	62-63	12/1	159,000	None	Slight cracking to L&P	None	20.0
13	Westwood	60-61	12/1	128,000	Tile facing crkd.	Drywl. crkd. all flrs.	None	22.0
14	Hollywood	65-67	12/1	200,000	None	Slight drywl. crkd.	AC moved	20.0
15	Hollywood	55-56	13/0	95,000	Windows all flrs.	Crkd. drywl. 3rd to 9th	Beacon light fell	20.0
16	Wilshire	57-58	13/1	200,000	Tile loose	Crkd. bsmt. walls (conc.), crkd. L&P	None	22.5
17	Hollywood	68-69	14/0	188,000	None	Crkd. ML&P walls thruout	None	20.0
18	Westwood	61-62	15/2	231,000	Window crkd. 8th	2 cracks in drywl., books fell	None	22.0
19	Sunset Strip	63-64	15/1	140,000	None	Crkd., ML&P drywl. all flrs.	AC out of adjust	20.0
20	Century City	68-70	15/3	340,000	None	Stairwell conc. wall crkd.	None	23.0
21	Miracle Mile	63-64	18/1	160,000	None	Crkd. drywl. all flrs.	Slight elev. damg.	22.5
22	Hollywood	61-64	19/3	90,000	None	Crkd. ML&P walls	Cable in elev. damg.	20.0
23	Miracle Mile	59-61	22/1	210,000	None	Crkd. ML&P core, books fell	Elev. damg.	22.5
24	Wilshire	60-61	22/1	453,000	Marble crkd. in lobby	Crkd. drywl. 4th to 14th	Elev. cables jumped	22.5
25	Wilshire	61-63	22/1	356,000	Ext. conc. walls crkd.	Ceiling tile fell, books fell	Elev. wts. moved	22.5
26	Westwood	69-70	24/4	605,000	Window seals broken	Conc. flrs. crkd. 21st to 25th	Elev. cable & wts. moved	22.0
27	Wilshire	67-69	31/1	750,000	Marble broke in lobby	ML&P walls crkd. all flrs.	Elev. cables damg.	22.5
28	Miracle Mile	1968	31/4	475,000	None	Crkd. drywl. all flrs.	Elev. broke loose from track	22.5
29	Downtown L.A.	1963	32/2	700,000	Tile damage ext. walls	L&P walls crkd. all flrs.	AC fan shifted	24.0
30	Downtown L.A.	65-67	42/	700,000	None	L&P cores crkd. stairs & elev.	Elev. cables damg.	24.0

*Area is total square footage above grade

observed damage patterns were about the same. Flexibly framed buildings, whether concrete or steel, suffered mostly cosmetic damage on February 9th when relatively stiff stair-elevator and utility cores within the frame experienced large story-to-story relative movements. Elevator cables and the containment of elevator counterweights in the taller buildings were damaged and caused damage, and these features necessarily must receive more design attention in the future.

The greatest reported dollar loss to a completed steel frame building occurred in a 42 story building in downtown Los Angeles, 24 miles from the epicenter. Here, a $200,000 loss to plastered partitions and elevator equipment resulted. Considering a $20,700,000 original investment in 1965-67, the loss represents almost 1% of value.

A 22 story steel framed structure built in 1961-63 in the Wilshire District suffered a $100,000 loss, just slightly greater than 1% of value, when an exterior concrete shear wall cracked, ceiling tiles fell and elevator counter balance weights were dislodged.

The twin 52 story office towers of the $175 million dollar Atlantic-Richfield Plaza Towers in downtown Los Angeles were in the latter stages of construction when the earthquake occurred. Apparently, a 25% increase in the number of cracks in the welds in the two lower stories of both steel framed towers was found after the earthquake, with this increase seemingly due to the earthquake. Miniscule cracks in the welds connecting heavy metal members occur during the normal welding process and these cracks are normal to this work; routine ultrasonic testing is used to discover these cracks and allow for repairs. It is premature to speculate very far into this particular case due to the lack of time and detailed information, but the potential problem of earthquake induced weld stress cracks in modern steel frame buildings is disquieting. Additionally, there is no assurance that all welded steel frame buildings will be as adequately inspected as was the Atlantic-Richfield towers. The cost of the repair of all welds, regardless of origin, has been placed at $400,000.

COMPARATIVE DATA

Figures 47 and 48 show dollar losses in terms of cents per square foot of total floor area (above ground) as functions of epicentral distance and of types of construction (concrete and steel). Dollar losses include building and equipment repair costs. Occasionally, contents losses were included when they could not be segregated, but these contents losses were small and have no significant effect on the conclusions. The following conclusions may be drawn from an examination of figures 47 and 48.

1. Steel frame and reinforced concrete high-rise generally performed equally well when located 15 to 25 miles from the epicenter, with exception as noted in (4), below.
2. No simple insurance rating or underwriting guidelines for story height vs. epicentral distance can be established solely from this earthquake. No doubt, local geology and the building's natural periods of vibration played significant roles.
3. The loss per square foot was under 15 cents for 82 percent of all examined buildings.
4. Where exceptions occurred to (1) and (3), above, they were usually adverse with respect to reinforced concrete construction, as follows:

Dollar Loss in Cents per sq. ft.	Material
680.	Concrete
192.	Concrete
65.5	Concrete
41.7	Concrete
35.5	Concrete
35.0	Steel
33.3	Concrete
29.5	Concrete
28.3	Steel
28.0	Steel

The foregoing experience suggests that reinforced concrete high-rise buildings will, upon occasion, experience a greater degree of significant damage than will comparable steel frame structures.

From a percentage loss standpoint, completed steel frame buildings never exceeded about 1% of value. A total of 5 reinforced concrete structures had losses over 1%, and two of these had losses over 5%.

NON-EARTHQUAKE RESISTIVE HIGH-RISE BUILDINGS

Older non-earthquake resistive high-rise buildings performed quite badly when compared to modern high-rise construction, based on limited selected information on older structures in the downtown Los Angeles area.

The buildings in Table 15 were erected between the years of 1906 and 1916, prior to the enactment of earthquake requirements in the Los Angeles City code. That is, the engineering design considered only the vertical loadings and not earthquake forces. However, during that construction period, fireproofing of the *steel frames* often was a monolithic concrete covering which inherently developed a strong "composite" structure of steel and concrete. This is not common under present construction methods which employ a sprayed-on light weight asbestos material.